Abstract: The analysis of proximate compositions and mineral values of four commonly eaten leafy vegetables in Hong were carried out. The minerals in the leafy vegetables were analysed using Atomic Absorption Spectrophotometer, while the proximate composition was determined following standard analytical procedures. The vegetables were Balanites aegyptiaca, Moringa oleifera, Bitter leaf and Blood plum. The results of the analysis of the proximate composition showed that moisture content, ash content, crude lipid, crude fibre, crude protein and carbohydrate ranged 5.00% - 6.50%, 7.50% - 17.00%, 2.84% - 9.33%, 4.15% - 7.52%, 22.8 – 30.55%, 37.6 – 50.59% respectively. The result of the mineral analysis revealed that the leafy vegetables contained the following minerals Ca (53.921 ± 0.22mg/kg - 203.542 ± 0.32mg/kg), Mg (28.921 ± 0.21mg/kg - 124.156 ± 0.11mg/kg), Mn (2.817 ± 0.05mg/kg - 13.085 ± 0.09mg/kg), Zn (0.851 ± 0.01mg/kg - 3.015 ± 0.11mg/kg), Pb (0.001 ± 0.00mg/kg - 0.007 ± 0.01mg/kg) and Cd (0.001 ± 0.00mg/kg - 0.007±0.01mg/kg). The four leafy vegetables were found to contain appreciable amount of minerals and proximate composition indicating they are good sources of nutrients to human body.

Keywords: Proximate, Mineral, Composition, Analysis, Leafy and vegetables.

INTRODUCTION

Green leafy vegetables constitute an important part of human diet in Africa. Some are cultivated while some occur in the wild (Grubben, 1977; Chouldhury, 1997; Timothy, 2020). Vegetables are the edible parts of plant that are consumed wholly or in parts, raw or cooked as part of main dish or salad. A vegetable includes flowers, fruits, seed, bulbs, tubers, leaves, stems, roots, and fungi (Uzo, 1989; Uwaegbute, 1989). Vegetables are good sources of vitamins, minerals, oil, and carbohydrates depending on the vegetable consumed (Ihekoronye & Ngoddy, 1985).

Traditional vegetables are important items of diet in many Nigerian homes and they are valuable sources of nutrients especially in rural areas where they contribute substantially to vitamins, fiber, protein, mineral, and other nutrients which are usually in short supply in daily diets (Mosha & Ga, 1999; Williams et al., 2019).

They are the cheapest and most abundant sources of protein (Fasuyi, 2006) and add flavor, color, variety, taste, and aesthetic appeal to diet (Mepba et al., 2002; Mohammed & Sharif, 2011). It is worthwhile to note that consumption of numerous types of edible plants as sources of food could be beneficial to nutritionally marginal population especially in developing countries where poverty and climate is causing havoc to the rural populace.

In many developing countries the supply of minerals is inadequate to meet the mineral requirements of farm animals and rapidly growing human population. Minerals must be provided from plants or mineral-rich water since it cannot be synthesized by animals. Green leafy vegetables are not only useful to man but also to his domesticated animals (Anjorin et al., 2010).

Nigeria is endowed with numerous varieties of useful plants whose fruits, seeds, stems, roots and leaves serve various important roles in nutrition and medicine (Adebowale et al., 2013). Unfortunately many of such plants have not been put into maximum use (McBurney et al., 2004). The neglect of these wild food plants has been attributed to the inadequate information on their nutritional profile and potential to serve as food security (Afolayan & Jimoh 2009).
The United Nation Food and Agriculture Organization (UNFAO) have estimated that the number of undernourished people in developing countries was 824 million in 1990-1992. In 2010, the number had climbed to 925 million people. The target set at the 1996 World Food Summit was to halve the number of undernourished people by 2015 from their number in 1990-1992 (FAO, 2004).

This problem of malnutrition can be reduced by encouraging the use of common vegetables, as they remain the cheapest source of proteins, minerals and vitamins in the diet of many people (Grivetti & Ogle, 2000; Lyimo et al., 2003). Vegetable oil and fats lower blood lipids thereby reducing the occurrence of diseases associated with damage of coronary artery (Ononugbu, 2002). With the global focus on increased food production and emphasis on provision of nutritious food for the worlds teeming population (Ossi, & Nndukwe 2002), it is necessary to consider our locally available vegetables and to determine their nutrient composition for the purpose of increasing the production of such vegetables (Asibay-berko & Tayie 1999; Bhandari & Kawabata 2006; Cole 1980).

Balanites aegytiace belongs to the family Balanitaceae. The plant is a tree and is a native of Jordan brought into Africa. Has a height of about 1600m and grows in a sandy soil of semi-arid region. They are used as fire wood and charcoal. The edible fruits are eaten by goats, camel and sheep. They are used as soap substitutes because of high saponin contents. The plant is thorny while the extracts of the fruits and bark are lethal to schistosomiasis and water fleas, (host for guinea worms) and contains sapogenins. The bitter leaf is believed to help restore the sterma when consumed in form of a tonic food called indole (Ghanafarin, 1989; Aremu et al., 2015).

Blood plum (Haematostaphis barteri) is a wild edible vegetable belonging to the Anacardiaceae family. It is a perennial tree crop which normally grows wildly in the forest and usually among savannah (Aremu et al., 2015). The tree is found wild in Borno, Adamawa and Taraba States of Nigeria, and it is known as Jinin Kafiri in Hausa language (Bokhari & Ahmed, 1979). The leaves of blood plum are used for seasoning soup in some local government areas of Adamawa and Taraba states as well as animal feed.

It is also used in nursing the snake bite victims, therefore, the plant bark is also used in treating liver, gall bladder, spleen disorders and jaundice, whereas the wood is used as firewood. The H. barteni fruit has oily seed which is edible (Bokhari & Ahmed, 1979).

The purpose of the study was to evaluate the proximate composition and mineral constituents of the four selected leafy vegetables.

**Materials and Methods**

**Plant sample collection and preparation**

Four different leafy vegetables (Balanites aegytiace, Moringa oleifera, Bitter leaf and Blood plum) were collected from different locations in Hong local government area of Adamawa State. The leaves were detached from the stalk. Part of the detached leaves was used for moisture content determination.

The remaining leaves were rinsed with deionized water and sun dried for 7 days on a clean paper with constant turning over to avert fungal growth (Onwordi et al., 2009).

The dried leaves were ground into powder using pestle and mortar. The grinded portion was kept in a plastic bottle in a freezer prior analysis.

**Proximate Analysis**

Moisture, ash, crude protein, fat content, carbohydrate and crude fibre were determined following the official methods of the association of official analytical chemists (AOAC 2000), while nitrogen was determined by the micro-kjeldahl method (Pearson, 1976) and the percentage of nitrogen was converted to crude protein by multiplying by 6.25. Carbohydrate was determined by difference (Onwordi et al., 2009).
results were presented in the form of a percentage on dry weight bases.

Mineral Analysis

The minerals in the leafy vegetables were analysed using Atomic absorption spectrophotometer (Buck scientific model 200A) from solution obtained when 2.0g of the samples were digested with concentrated nitric acid and concentrated perchloric acid in ratio 5:3, the mixtures were placed on a water bath for three hours at 80°C. The resultant solution was cooled and filtered into 100ml standard flask and made to mark with distilled water (Asalu, 1995).

**RESULTS AND DISCUSSION**

The results of the proximate composition and minerals analysis together with their FAO/WHO standard values were presented in Tables 1 and 2 respectively.

<table>
<thead>
<tr>
<th>Table 1: Shows the result of proximate composition analysis of the selected vegetables in Hong (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bitter leaf</strong></td>
</tr>
<tr>
<td>Moisture content</td>
</tr>
<tr>
<td>Ash content</td>
</tr>
<tr>
<td>Crude lipid</td>
</tr>
<tr>
<td>Crude fibre</td>
</tr>
<tr>
<td>Crude protein</td>
</tr>
<tr>
<td>Carbohydrate</td>
</tr>
</tbody>
</table>

**Table 2: Shows the result of mineral composition of the selected vegetables in Hong (mg/kg)**

<table>
<thead>
<tr>
<th><strong>Bitter leaf</strong></th>
<th><strong>Moringa oleifera</strong></th>
<th><strong>Balanites aegytiace</strong></th>
<th><strong>Blood plum</strong></th>
<th><strong>FAO/WHO</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn</td>
<td>1.523±0.02</td>
<td>3.015±0.11</td>
<td>1.122±0.01</td>
<td>0.851±0.01</td>
</tr>
<tr>
<td>Mg</td>
<td>52.62±0.06</td>
<td>124.156±0.11</td>
<td>65.082±0.12</td>
<td>28.921±0.21</td>
</tr>
<tr>
<td>Mn</td>
<td>9.235±0.09</td>
<td>13.085±0.09</td>
<td>2.817±0.05</td>
<td>3.440±0.03</td>
</tr>
<tr>
<td>Pb</td>
<td>0.001±0.00</td>
<td>0.002±0.00</td>
<td>0.007±0.01</td>
<td>0.002±0.00</td>
</tr>
<tr>
<td>Cd</td>
<td>0.002±0.00</td>
<td>0.001±0.00</td>
<td>0.004±0.01</td>
<td>0.002±0.01</td>
</tr>
<tr>
<td>Ca</td>
<td>53.921±0.22</td>
<td>203.542±0.32</td>
<td>102.340±0.51</td>
<td>72.612±0.02</td>
</tr>
</tbody>
</table>

The proximate chemical analysis of food is the nutritional composition of that food; it is the estimation of the nutritive value of human food in chemical form. The result of the proximate chemical analysis revealed the presence of Moisture content, Ash content, Crude lipid, Crude fibre, Crude protein and Carbohydrate. Carbohydrate was found to be the highest (Table 1).

In this work the moisture content observed range from 5.00% - 6.50% which was observed in Moringa oleifera and Bitter leaf respectively (Table 1). Moisture content is among the most vital and mostly used measurement in the processing, preservation and storage of food (Mann & Otori, 2014).

The ash content ranged from 7.50% - 17.00% the smallest value was observed in Moringa oleifera and the largest value in Blood plum (Table 1). Ash in food is the residue remaining after all the moisture has been removed as well as the organic materials (organic acid, fat, protein, carbohydrate, vitamins, etc) have been incinerated at a temperature of about 500°C (Boroomand & Grouh, 2012; Mann & Otori, 2014). Ash content is generally taken to be a measure of the mineral content of the original food.

Crude lipid ranges from 2.84% - 9.33% the minimum value was observed in Moringa oleifera while the maximum in Bitter leaf (Table 1). The value did not exceed the FAO/WHO value. Lipid provides very good sources of energy, aid in transport of insulates and fat soluble vitamins. It also protects internal tissues and contributes to important cell processes. Many body functions depend on lipids because it is the principal sources of energy. Therefore it is good to add lipid (fat) to most of our diets. One gram of lipid provides 9.0 kcal (37.33 kJ) of energy (Mann & Otori, 2014). The crude lipid can be used for storage and transport forms of metabolic fuel.

In this research Crude fibre was found to range from 4.15% - 7.52% which was observed in Moringa oleifera and Bitter leaf respectively (Table 1). The value of crude fibre in plant or food is an indication of the level of carbohydrate and non-digestible lignin. Plants with high fibre are adequate for better rumination and digestion in ruminant animals (Boroomand & Grouh, 2012; Adinortey et al., 2012). The result obtained in this study showed a good amount of fibre, which indicate the plant can serve as a good source of fibre that can aid digestion, help in reducing the risk of coronary heart disease, serum cholesterol level, intracolonic pressure that is beneficial in diverticular disease and hypertension. The high fibre content is a further confirmation of its use as vegetable. Thou the value did not exceed the FAO/WHO value.

Crude protein obtained from the result showed the range 22.8% - 30.55% (Table 1), which shows appreciable value, thou the values were below FAO/WHO standard limit. Consumption of protein...
helps in the building of essential and non-essential amino acid for protein synthesis.

The proximate analysis revealed a relatively high % of carbohydrate which range from 37.6 – 50.59% (Table 1). The amount of carbohydrate detected showed that the vegetables could be consumed as a source of carbohydrate especially in tropical where carbohydrate contributes up to 80 % daily caloric need. Carbohydrate are utilize as major sources of biological energy (Habtamu et al., 2014). Though the values were below FAO/WHO standard limit

The mineral analysis showed that the concentration of Zinc in this study ranged from 0.851±0.02mg/kg to 3.015±0.01mg/kg. The high and the low values were observed in Blood plum and Moringa oleifera respectively. However the values did not exceed the standard value of FAO/WHO (Table 2). Zn is involved in the normal function of the immune system. Therefore people are encouraged to eat these types of vegetables so that their immune system can function well. Nutritionists have considered the role of zinc in human (Udayakumar & Begum, 2004), and recommended that they should be considered for preparation of herbal drugs (Sadia et al., 2011).

Magnesium concentration in this study ranged from 28.92±0.01mg/kg to 124.15±0.11mg/kg. The maximum and the minimum values were observed in Blood plum and Moringa oleifera respectively. All the values were above the standard values of FAO/WHO (Table 2). High magnesium concentration is a component of leaf chlorophyll in plants. Magnesium is an important mineral element in connection with circulatory diseases such as heart disease (Nwauzoma & Dawari, 2013). It is also an active component of several enzyme systems in which thymine pyrophosphate is cofactor oxidative phosphorylation is greatly reduced in the absence of magnesium. Common forms of Mg deficiency in human include respiration and depressed deep tendon reflexes. Sources include green vegetables and leaves (Afolayan & Jimoh, 2009).

The result in this study showed that the Mn ranged from mg/kg 2.817±0.05mg/kg - 13.085±0.09mg/kg (table 1). All the values were found to be higher than the value recorded in cassia occidentalis (Williams et al., 2019), which means the vegetables are rich in Mn. Therefore eating of the vegetables is encouraged to activate several important enzyme systems in the body. Manganese is a microelement essential for human nutrient; it acts as an activator of many enzymes. It is also a cofactor of Decarboxylase, transfenses enzymes and hydrolase (Vashishtha et al., 2007; Victor & Chidi, 2009). Mn activates several important enzyme systems; therefore it is required for the synthesis of acid mono polysaccharides, such as chondroitin sulphate, to form the matrices of bone and eggshell. When the Mn intake is inadequate skeletal deformity defects in shell quality occur (Mohammed & Sharif, 2011).

The concentration of Pb ranged from 0.001±0.00mg/kg - 0.007±0.01mg/kg. The high and the low values were observed in Bitter leaf and Balanites aegytiace respectively (Table 2), which was much lower than the values observed in Maerua angolensis vegetables (Williams et al., 2019). Therefore, this plant is safe for consumption since this toxic element is in very low concentration. Pb causes reproductive dysfunction which decreases sperm quality and altered sperm morphology and low androgen level (Asaolu & Asaolu, 2010). Lead occurs naturally in the environment. Every one may be exposed to trace amount of lead through house hold dust, drinking water, food, air, soil, and various consumer products (Njidda et al., 2013).

Cadmium concentration was found to range from 0.001mg/kg - 0.004 mg/kg. The maximum and the minimum values were observed in Moringa oleifera and Balanites aegytiace respectively. (Table 2). Cadmium is a very toxic metal that should be monitored to prevent Cd related diseases. Cadmium compounds are classified as carcinogens by several regulatory bodies (Dusa et al., 2017). On longer time of accumulation, Cd at certain concentration can cause kidney, liver, heart, brain and eye problem (Bamishaiye et al., 2011).

The concentration of Ca ranged from 53.92±0.22mg/kg - 203.54±0.32mg/kg as observed in Bitter leaf and Moringa oleifera respectively (Table 2), which was much higher than the values observed in Maerua angolensis vegetables (Williams et al., 2019). Therefore the studied plants are essential in building the level of calcium in the body. Calcium plays an important role in building and maintaining strong bones and teeth, extracellular fluids and large part of human blood. Approximately about 99% of the body calcium is stored in the bones and teeth (Victor & Chidi, 2009; Williams et al., 2019).

**CONCLUSION**

The study revealed that the leaves of Bitter leaf, Moringa oleifera, Balanites aegytiace and Blood plum contain appreciable amount of essential nutrient and minerals needed for the maintenance of good nutritional status and they compete favourably with other vegetables. The result suggest that the vegetables if consume in sufficient amount would contribute greatly towards meeting human and animal nutritional requirement for normal growth and adequate protection against diseases arising from malnutrition. It is recommended that the leafy vegetables should not be taken solely as enough substitutes for foods but rather to support the major classes of food as they cannot meet all the required dietary allowances of the body.
REFERENCE


17. FAO (Food and Agriculture Organization). (2004). The state of food security in the world. Rome, Italy: Economic and Social Department.


